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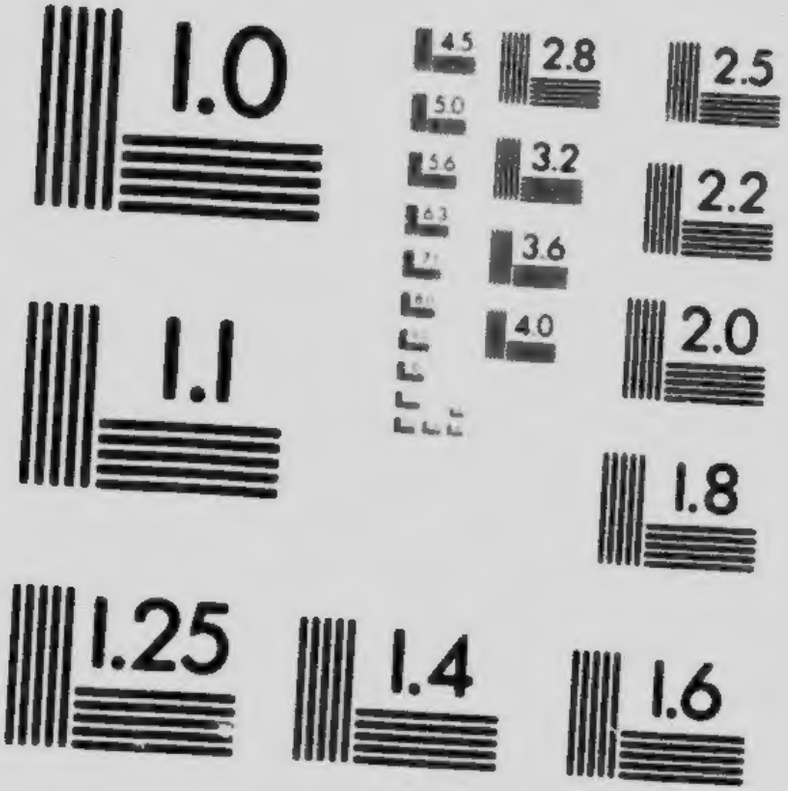

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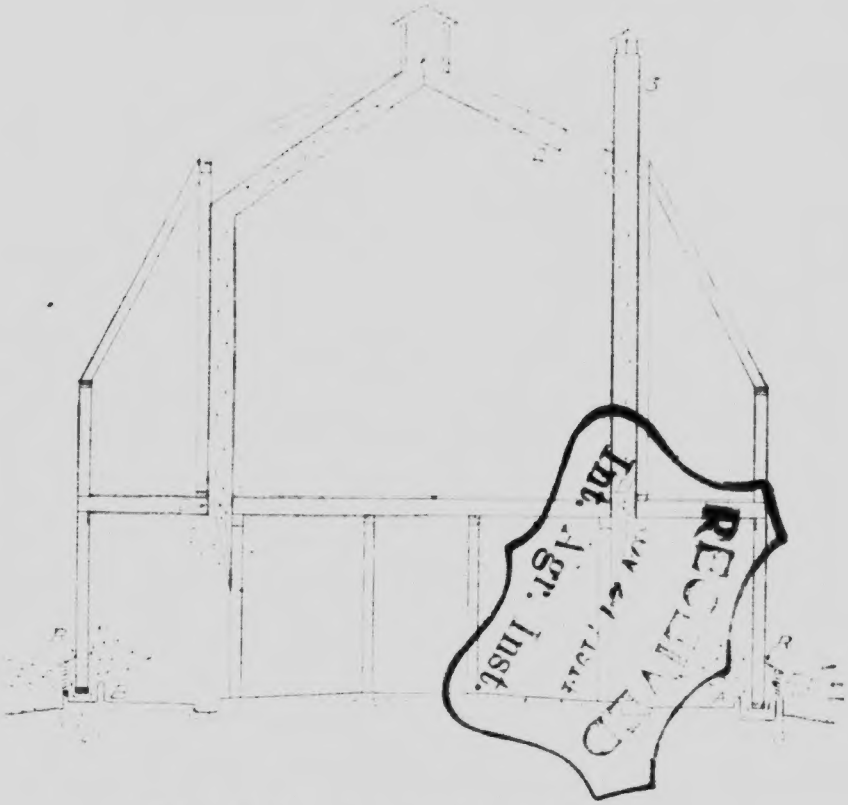
Bulletin No. 13 *May, 1914*

BARN VENTILATION



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Manitoba Agricultural College

Winnipeg, Canada

L. J. Smith, B. S., Professor of Agricultural Engineering

Published by the Authority of Hon. Geo. Lawrence, Minister of Agriculture and Immigration.

Manitoba Agricultural College
Winnipeg,
May 29th, 1914

To the Hon. George Lawrence,
Minister of Agriculture and Immigration,
Parliament Buildings,
Winnipeg, Manitoba

Dear Sir:

I beg to present herewith Bulletin No. 13 of the Manitoba Agricultural College entitled "Barn Ventilation," by L. J. Smith Professor of Agricultural Engineering.

This Bulletin is not intended as an exhaustive treatise on [illegible], nor as representing special investigational work carried [illegible] the College. It describes systems of ventilation, and [illegible] information intended to be helpful to many farmers of [illegible] from whom enquiries are being received on the subject.

Yours very truly,
W. J. BLACK,
President

Barn Ventilation.

INTRODUCTION

Only in recent years has the farmer come to realize the necessity of good barns for the maintenance of the health of those animals that are shut in, for at least the greater portion of the winter season. In erecting these barns, three important items of construction, necessary to the health of the stock to be housed, must not be overlooked, namely: good lighting, a sanitary interior and some means of affording ample ventilation.

Sanitary Consideration in barn building.

Abundance of light and ventilation must be had, even at the expense of heat, in the stable. Windows should be fairly small and uniformly distributed, rather than very large and few in number. They should be located high enough to let the sunlight well into the centre of the barn. Any cold air leaking in around the windows, under these conditions, will have time to mix with the warmer air at the top of the stable before reaching the stock. Putting windows so high also reduces glass breakage to a minimum. There should be one square foot of glass to every twenty or twenty-five square feet of floor space. The glass should be cleaned at least twice a year, in order not to cut off sunlight. This does not mean a painstaking washing and drying of windows, such as is done by the housewife, but merely a washing to get off the dust and cobwebs. The interior walls should be smooth so as to be easily brushed down, and should be whitewashed both for sanitary purposes and to prevent absorption of light. The stable floors should be of concrete to afford easy cleaning and cleansing, and to prevent absorption of liquids.

BARN VENTILATION IN GENERAL

Why ventilate Barns.

Barn ventilation is necessary for various reasons: to remove dust in the air, impurities from the skin, vapors and odours arising from the manures; to carry off the carbonic acid gas breathed from the lungs of the animals, and to replace it with pure outside air; to keep down the amount of moisture in the air in the barn; to regulate the temperature of the

stable, and to [illegible] germs. If one animal in a stable has tuberculosis, the chances are strongly in favor of other animals contracting the disease unless the stable be flooded with sunlight, and kept well cleaned, and unless the air is changed frequently.

Limitations of a ventilation system.

No natural system of ventilation has yet been devised, or probably ever will be devised, that will work entirely automatically. Like everything else, its operation needs some attention. Nor is it possible to give the animals in the average barn all the air that is considered necessary, and still keep the inside temperature above freezing during the coldest portions of Manitoba's winter months. Still, even during the two coldest months, the temperature rises sufficiently high so that a full amount of ventilation can be had part of the time, and a fair amount nearly all the time. At the same time it is possible to have a good system of ventilation in a barn, and still be very unsatisfactory, because of a lack of knowledge or attention in operating it.

How a natural ventilation system operates.

All natural systems of ventilation work on the same principle. Warm air rises. Out-take flues are provided, passing up through the loft of the barn; the warm air rises through the flues and equal volumes of colder air are drawn into the barn through intake flues arranged along the sides of the stable, and by leakage around the doors and windows, and in many cases, through the walls of the stable. The principle of ventilation is the same as the draft in the ordinary stove or furnace. In barn ventilation, the animals furnish the heat necessary to cause the circulation of the air.

Factors to be considered in regulating barn ventilation.

The efficiency of the system of ventilation adopted is dependent upon several factors, namely, the position and size of in-take and out-take flues, the [illegible] oldness of the inside of the out-take flues and the number [illegible] bends in the same, the rate at which the wind is blowing, and the difference in temperature between the inside and outside of the barn. As regards position of the flues, the higher the out-take the greater the draft. Their size must be figured so as to ensure ventilation under most adverse natural conditions, such as for quiet weather, and for the cool weather at the beginning and end of winter, for under such conditions the air moves at its slowest rate up the out-take flues. Other things being equal the circulation of air through the flues will be more rapid in windy than in quiet weather. In regard to the effect of difference in temperature, a partially filled stable, too much wall space caused by unnecessary high walls, poorly built walls, ill fitting doors and windows, waste space due to unnecessarily large passages, stalls

etc. all tend to reduce the temperature of the stable and cause an unnecessarily restricted ventilation in the coldest weather.

The air intake and air take flues must have some means whereby the openings may be restricted in extreme cold or windy weather. The air take flues must be air tight and smooth on inside, and should have as few bends as possible. The air intake flue is a part or independent of the walls [illegible] are constructed of four thickness of wall, the outer layer being the 1" longer and covered with shiplap, with a layer of building paper between and two layers of building paper on the inside. The flues must end at least level with the crown of the roof to prevent the wind blowing down the flue [illegible]

Construction.

If any system of ventilation [illegible] must be fairly tight, and the [illegible] unless there is a thick layer [illegible] inside of the studding of the [illegible] joint, or tongue and grooved [illegible] conditions, the wall outside the [illegible] should consist of one layer of shiplap [illegible] thickness of building paper and [illegible] the stock well. The loft floor [illegible] of the floor least exposed [illegible] the loft floor. The [illegible] joint, or tongue and grooved with V [illegible] Manitoba [illegible] to the loft floor [illegible] at least one [illegible] siding

Construction of walls and floors.

The two systems of Barn Ventilation

There are only two systems of barn ventilation that have thus far proved their worth [illegible] successful in our cold weather conditions unless [illegible] and carefully operated. One system is known as the Rutherford and the other as the [illegible] system. The Chief intends to experiment with these systems with various modifications, in order to determine which is best adapted to Manitoba conditions. In the meantime this bulletin is contributed to give the reader, in as brief a manner as possible, an elementary knowledge of the systems already in use, with some suggestions and comparisons. It should be understood that this bulletin treats of Manitoba conditions.

THE RUTHERFORD SYSTEM

Intakes.

Figure 2 illustrates the Rutherford system of ventilation in a gambrel roof barn with purlin posts. The fresh air enters the intake flues just above the ground level, turns downward,

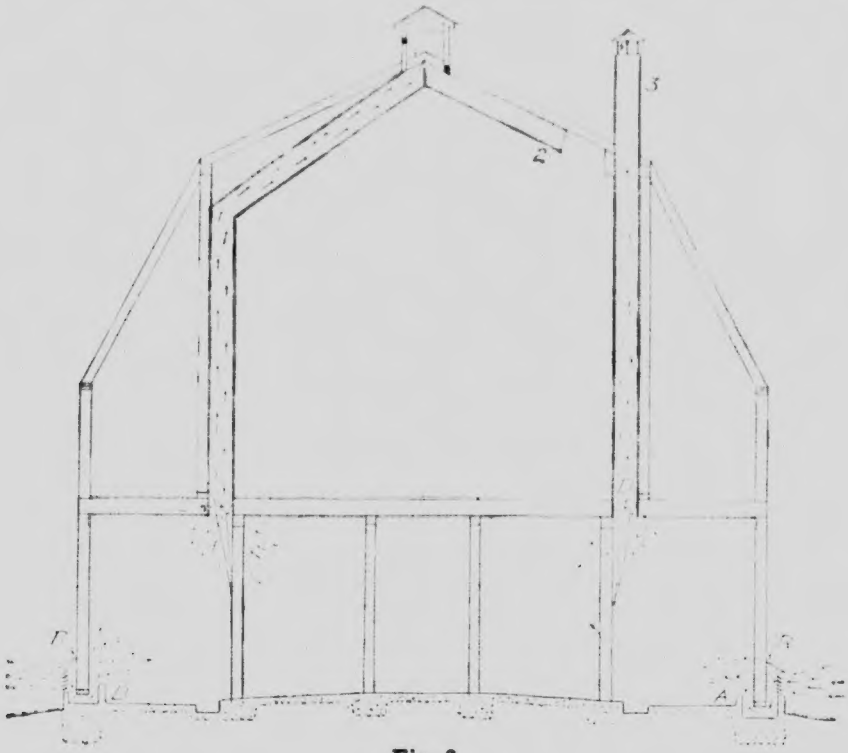

Fig. 2.

[illegible] square inches of inlet area per head of cattle is recommended. Horses should be given 10 to 12 square inches of inlet area. If a barn contains 50 head of stock the total area of the intake flues should not be more than 300 square inches. If four in-take flues were put in the area of each would be 75 square inches, or an opening 6x13 inches which would make a bad draft. If six in-take flues were used the area of each would be 50 square inches, or less, which would give an opening about 4x12. For our conditions a large number of smaller intakes would be greatly preferable to a small number of large in-takes.

Size and number of intakes.

The out-take flues start at the ceiling and pass up through the loft (usually alongside the purlin posts, if there are any) to the cupola, being put in in pairs in large barns. There will probably be one or two in the small barn, four in the ordinary barn, and six in the very large barn. The out-take flues can be carried up through the roof in various ways. At 1, the flue leaves the purlin post and takes a steeper slant up to the cupola, which is better than 2 in so far as the ventilation system is concerned, but takes more space in the loft. Number 3 affords the most direct exit for the foul air and is, in the writer's opinion, the best one to use. It is a little unsightly and the outgoing air cools a little more rapidly in the portion above the roof exposed to the direct contact of the cold winter winds, but the suction is greater, and the hay track can be put in higher by not having the outlets feed into the cupolas. Also the cost of construction should be, if anything, a little less in the case of the straight out-take flue. When installing out-take flues, avoid carrying the flues along horizontally when it is necessary to get to the cupola, but rather keep the flues slanting upwards.

Number and position of out-take flues.

The total area of the outlet flues in the Rutherford system is made twice the total area of the in-take flues. In other words, sixteen or more square inches of out-take flue is allowed

Size and regulation of out-takes.

for each cow, and a little more for horses. Thus it is figured (and correctly so) that a good deal of the fresh air entering the stable comes in around the doors, windows, etc. The outlet flues are controlled by means of dampers D D pivoted in the centre and regulated by a cord. These dampers should fit well. It has been found best to entirely close one side of the out-takes in very cold weather, rather than to partially close all. In the latter case the flues would not draw enough air to keep them warm, and they would condense the moisture in the outgoing air, and fill with frost. [illegible] could close [illegible] fairly well the next time [illegible]

THE RING SYSTEM

Intake-flues. [illegible] The [illegible] system differentiates the fresh air coming in the intake flues at about the crown of each [illegible] and those between the [illegible] and the floor [illegible] of the flue [illegible]

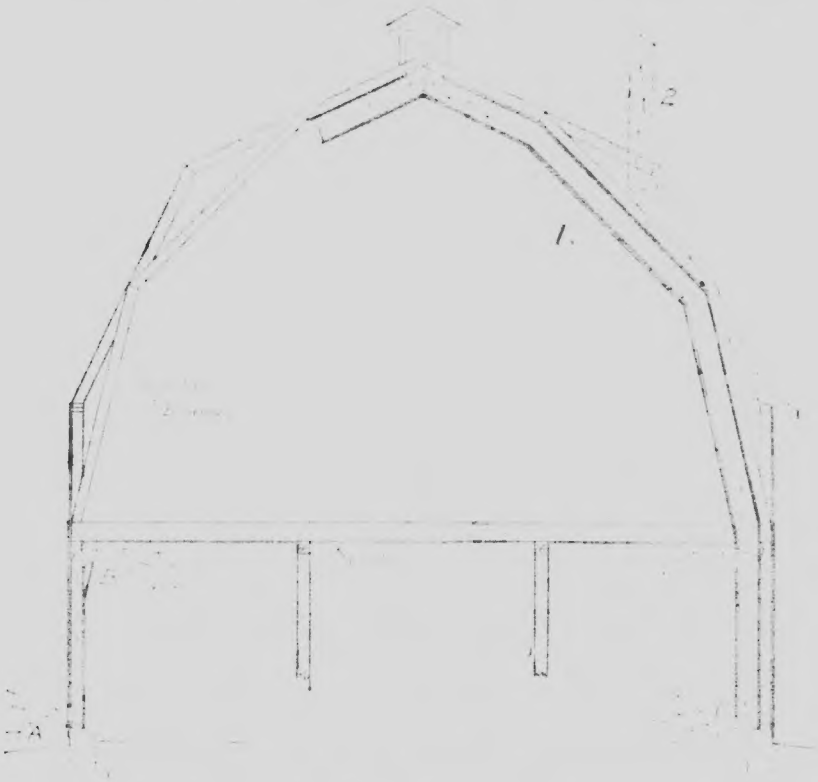

Fig. 3.

ing the stable a foot below the ceiling [illegible] the cold incoming air mixes with the warmest air in the stable with the idea of avoiding as much as possible [illegible] openings should be placed as slightly [illegible] in order to prevent the cold incoming air [illegible] the stable. [illegible] intake shafts [illegible] intake conditions [illegible] to the [illegible] The [illegible] inside opening [illegible] inside [illegible] horizontal [illegible] stalls facing [illegible] the [illegible]

Arrangement of out-take flues.

The out-take [illegible] the floor at E [illegible] the roof, one foot [illegible] In the stable proper the flues are [illegible] they are [illegible] to protect [illegible] but at the top they should be [illegible] outside air [illegible] They [illegible] in various ways; they [illegible] they may pass out [illegible] they may pass out along the roof, side [illegible] being the best [illegible] When [illegible] the barn the [illegible] supporting the roof [illegible] the roof beside the porch posts [illegible] same as [illegible]

Intake flues.

While it will [illegible] flue at the floor [illegible] D is only that the [illegible] when the temperature of the stable [illegible] ing can be controlled by a slide [illegible] shown at D is by a damper instead of the [illegible] method shown at F [illegible]

Size of flues.

In the [illegible] and of the intake flues [illegible] is satisfactory [illegible] in the prairie provinces [illegible] to have the total area of the intake openings about two-thirds that of the out take flues, for leakage around the windows and doors will easily provide one-third of the ventilation. From the following table it will be readily seen that the recommend

[illegible] amount of [illegible] per animal is much greater than that [illegible] system, which means that for flues of the same height and [illegible] in windy weather [illegible]

Area of Outtake Flues per Animal

[illegible]	[illegible]
[illegible]	[illegible]
Horse	[illegible]
Cow	[illegible]
Pig	[illegible]
Sheep	[illegible]

These figures provide ample area for still weather conditions and where the temperature is 15 or 20 degrees F. above zero. Under these conditions we have a slower movement of air than when it is colder and more windy. This means that the flue area must be greatly reduced in windy and extremely cold weather.

Frosting of in-take openings.

A slight objection to the King system of in-takes is, that the air rising through the flues makes the inside walls very cold, and in the coldest weather the moisture in the stable forms a thick layer of frost, or even ice sometimes, on the wall at these points, and then runs down the wall at the next rise in temperature if not kept scraped off. This trouble will occur, to some extent, around any in-take openings in the coldest weather. In the case of the King inlets it can be largely overcome by making a dead air space between the intake studding as shown at I, fig. 4.

FURTHER SUGGESTIONS

Flue Regulation.

With any system of ventilation, all the intake openings should be practically closed in cold weather rather than to entirely shut off some of them, except when the wind is blowing strongly against one side of the barn, in which case the intakes should be almost closed or entirely closed. A test of intake flues in windy weather will show nearly all, if not all, of the fresh air coming in on the windward side of the barn and none coming in on the opposite. But if the intake flue openings on the windward side are cut down, fresh air will be drawn in on

the opposite side also, thus giving a more uniform ventilation throughout the stable. In very cold weather all intakes are closed and half the out takes entirely shut off, and even all outlets should be closed but one when the temperature is extremely low.

A test of Barn Ventilation.

From a ten days test in the College Dairy Barn during the coldest part of last winter, it was found that with all intakes closed and only one of the four out takes open, sufficient air leaked in around the doors, windows, loft openings (closed) and shutters of the intake flues (Rutherford System) to change the air in the stable pretty close to three times an hour with an outside temperature of from 18 to 37 degrees F. below zero, and while the wind was blowing from 0 to 12 miles an hour. The temperature in the stable during this period varied from 37 to 47 degrees F. This is an exceptionally warm barn. It is brick veneered and has storm doors and windows. The wing tested contained thirty cattle.

A method of protecting inlet flues from heavy winds.

One of the main points to be watched in the operation of a ventilation system is the regulation of the intakes. If the intake flues are set for still weather conditons and a strong wind sets in before morning, the animals in the windward side of the barn get too much cold air. This is probably more true of the King inlet than the type of Rutherford inlet shown, though the King inlet gives the incoming air a better chance to spread

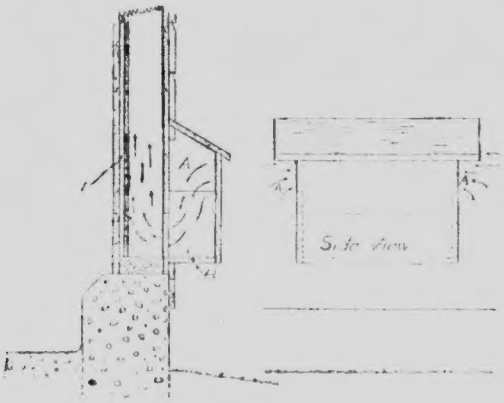

Fig. 4.

before reaching the animals. Figure 4 shows an arrangement for protecting the outside opening of the inlet flue from the direct force of the wind. There are no louvers on the front, but openings A, A, at each end directly under the little slanting

roof. The roof should overhang the opening about three inches. With this arrangement, if the wind is blowing squarely against the side of the barn, the ingoing air has to make two right angle turns before it can enter the intake flue proper which would considerably cut down the velocity of the entering air. If the size of the two openings A and B equals about two thirds of the area of the intake proper, this will help to reduce the velocity of the air entering the stable. If the wind is blowing against the side of the barn at an angle, it will cut some of the opening of A and blow out through the other side, and not much harm can come to the intake flue than in still weather. The bottom B need not be quite tight. There is the main force in under the little door, and it will only leak through.

No louvers in cupolas.

It has been found that it is better not to have louvers in the cupolas but rather to allow the wind to blow straight through. Cupolas should be made as tall as possible. There is a tendency to make them too low. Galvanized iron is preferable to tin for cupolas and to use galvanized iron cones instead both on barn ventilation and for ventilation of the hay loft. There are quite a number of good cupola manufacturers on the present day.

CONCLUSION

Either system of ventilation may be used with minor changes if the barn is already constructed, in bank barns or in barns whose walls are made of stone, brick or concrete. If the walls are made of other materials than wood, the inside should be stripped with 1x2 strips, placed vertically about two feet apart and covered with shiplap or ceiling material to form a dead air space.

Any further information concerning the installation of systems of ventilation can be had by addressing the Agricultural College.

LIST OF BULLETINS

Prepared by Manitoba Agricultural College, Winnipeg, Canada

No.	Title	Author
1.	"Classification of the Horse"	Prof. W. H. Peters
2.	"Twelve Noxious Weeds"	Prof. S. A. Bedford Prof. C. H. Lee
3.	"Care of Milk and Cream"	Prof. J. W. Mitchell
4.	"The Protection of Farm Buildings from Lightning"	Prof. L. J. Smith
5.	"The Farm Garden"	Prof. F. W. Brodrick
6.	"Farm Poultry in Manitoba"	M. C. Herner, B.S.A.
7.	"Hog Raising in Manitoba"	Prof. W. H. Peters
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9.	"Repairing Farm Equipment and Roads"	Agricultural Engineering Department
10.	"Plans for Farm Buildings"	Prof. J. J. Smith Robert Milne, B.S.A.
11.	"Canning and Preserving"	Bertha A. Duncan
12.	"The Farm Flock"	F. W. Crawford, B.S.A.
13.	"Barn Ventilation"	Prof. J. J. Smith

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